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Employment Dynamics and the Structure of Labor Adjustment Costs

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ABSTRACT

Employment Dynamics and the Structure of Labor Adjustment Costs*

In this paper we document the patterns of employment adjustment at the micro-level. We find clear evidence of lumpy adjustment consistent with the presence of non-convexities in the adjustment technology - inaction is pervasive, action spells are short-lived, extreme adjustment episodes occur and are responsible for a non-trivial share of employment adjustment. We also find that the probability of employment adjustment increases with the duration of inaction (positive duration dependence). The skill structure of the workforce, the type of employment contract and the proportion of low tenure workers, which we interpret as proxies for the magnitude of adjustment costs, all influence the probability of adjustment.

JEL Classification: J23, J63

Keywords: adjustment costs, job flows, worker flows, duration models

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1 Introduction

Labor economists long-standing interest in the behavior of productivity over the business cycle and the impact of job-security policies motivated a by-now large literature on the path of employment adjustment towards new steady-states. More recently, macroeconomists' attention has also been drawn at the micro-foundations of aggregate employment adjustment.

The standard approach to the dynamics of employment adjustment assumes a convex adjustment cost technology which generates a smooth, partial adjustment-like, path towards new equilibriums. [1] However, non-convex adjustment cost structure have consistently been found to fit micro-data better, outperforming alternative specifications of the adjustment cost function (Hamermesh 1989, 1993a; Anderson 1993; Rota, 1994). Empirical investigation of the patterns of factor adjustment have also documented the importance of "lumpy" adjustment. Although this is especially true for investment (Doms and Dunne, 1998; Gelos and Isgut, 2001; Nilsen and Schiantarelli, 2003), convincing evidence has also been presented for labor as well (Caballero et al., 1997).[2]

At the plant level, non-convexities in the adjustment technology shape the patterns of employment adjustment in at least four different ways. First, non-convex adjustment costs translate into the distribution of employment adjustment that is expected to exhibit a high proportion of extreme events. Fixed or linear adjustment costs imply that micro-units experience episodes of sharp adjustment followed by relatively long periods of no adjustment. Such a pattern of adjustment implies that a non-trivial share of aggregate employment adjustment is accounted for by these extreme events, which result in long fat tails of the employment change distribution.

Second, non-convex adjustment costs also imply that inaction is optimal even outside the steady-state, which is contrary to what occurs if adjustment costs are

[1]The same approach has also been adopted in the investment literature. In fact, much of what is said here applies more generally to the literature on factor demand.

[2]The importance of non-linearities has also been documented in the context of price adjustment - an early reference is Sheshinski and Weiss (1977).

convex. The fact that establishments or firms are inactive for a large number of time-periods is an indication of the importance of one type of adjustment costs over the other.

Third, for each employer, non-convex adjustment costs imply few, extreme and short-lived adjustment episodes, action being most likely followed by inaction. If, on the contrary, adjustment is smooth and persistent it must be that convex adjustment costs dominate.

Fourth, the presence of non-convexities in the adjustment technology implies that, besides sharp and rare, adjustment episodes are most likely followed by inaction.

In this paper we provide a detailed analysis of establishment-level employment adjustment. We focus on the nonconvex adjustment cost case and compare its various implications against Portuguese data. Differently put, we investigate if and how labor adjustment departs from the standard convex adjustment cost model. Our approach has two steps. First, we document the patterns of employment adjustment at the establishment level and quarterly frequency. Micro and quarterly (or more frequent) data are essential for studying the dynamics of factor adjustment because aggregation (spatial or temporal) smoothes away any nonlinearities present at the plant or firm levels (Hamermesh, 1993b). In the second step, we estimate the the probability of employment adjustment conditioning on the length of stay at a non-adjustment situation (that is, the hazard function). Controlling for worker attributes and using proxies for the costs of adjustment (such as the proportion of workers with low firing cost contracts and the skill-composition of the workforce) we obtain estimates of the relevant parameters. The slope of the hazard function is also of interest as it has been linked, under some assumptions, to the structure of the underlying adjustment costs (Power, 1994; Cooper et al., 1999; Nilsen and Schiantarelli, 2003).

In all the empirical work, we use Portuguese data. Portugal is an interesting case study because of its high levels of job protection which result in very high firing costs. Collective dismissal rules involving a substantial amount of red tape apply to the dismissal of as few as two or five employees depending on the size of the establishment being above or below a fifty-employee threshold. These and other similar rules are responsible for the fact that the Portuguese labor market emerges as the most regulated in Europe in all existing rankings of indexes of employment protection (*e.g.*, OECD, 1999) even if Portugal was the first country to introduce fixed-term contracts in Europe as soon as in 1976. These contracts were conceived as a form of flexibility at the margin by offering employers the opportunity of hiring new workers on a much less stringent basis. [3] In this sense, the evidence we present and the estimates we obtain may be thought of as upper-bounds for the corresponding results in other countries. At quarterly (but not yearly) frequencies, the magnitude of job flows in Portugal is much less than in other countries. [4]

The paper is organized as follows. In Section 2, the dataset used is described. The concentration of job and worker flows and the frequency of inaction are analyzed in Section 3. In Section 4 individual employment series are characterized and the presence of spikes in those series is investigated. In Section 5, employment regimes are defined and transitions across regimes are described. In Section 6, the statistical analysis of duration data is used to identify the role of the type of contracting and workforce characteristics on the probability of starting an adjustment episode. Section 7 concludes.

2 The Data

The data used in this article come from two sources: the *Inquérito ao Emprego Estruturado* (IEE) which is a quarterly survey with detailed information on job and worker flows at the establishment level and *Quadros de Pessoal* which is an annual longitudinal matched employer-employee dataset based on a survey mandatory for all establishments with wage earners. Both surveys are run by the Portuguese

[3]Despite they entail lower firing costs, fixed-term contracts are also subject to a number of restrictions that make them less flexible than they are in other European countries. For details on the institutional framework see Varejão and Portugal (2005).

[4]For a comparison with the U.S., see Blanchard and Portugal (2001).

Ministry of Employment. The two sources share the same establishment identifier and can therefore be merged.

Establishments of all sizes and in all industries are included in the IEE dataset.[5] The sample is drawn from the universe of the respondents to the 1990 spell of *Quadros de Pessoal* (QP). The probability of units with fewer than 100 employees being selected to the IEE sample is inversely related to the size of the establishment. Above that threshold, establishments are selected with certainty.[6] The sample is statistically representative for three-digit industries (as defined by the SIC code), region and size class. For this purpose, seven regions - five in mainland Portugal and the islands of Madeira and the Azores - were considered and six size classes were defined.

The IEE data used here span over twenty quarters, from the first quarter of 1991 until the last quarter of 1995. On average, 6,954 establishments respond to each spell of the survey.

The original twenty quarterly files were subsequently converted into two datasets that are, hereinafter, referred to as the pooled dataset and the longitudinal dataset.

The pooled dataset simply pools all the twenty quarterly files. No major modifications to the original files were made except that all records (127) with zero employment at both the beginning and end of period were deleted. The pooled dataset contains 139,076 records corresponding to 10,673 establishments. [7]

The longitudinal dataset results from merging the twenty quarterly files. All records in every quarterly file have an identification code that is unique and does not change during the whole period the establishment remains in the sample. This code number served as the key for merging the two original files. As a result, an unbalanced panel of 10,673 establishments was obtained.[8]

Quarterly measures of job flows were computed using the end-of-period head-

[5]Only Agriculture, Fisheries, Public Administration and Private Services are excluded.

[6]This threshold is set at 50 employees for the Azores and Madeira regions.

[7]Establishments are removed from the sample if they do not respond to three consecutive spells of the survey, meaning that shutdowns are accommodated although they cannot be distinguished from non-response (which is mandatory). Replacement establishments are drawn from the same spell of the *Quadros de Pessoal* datafile from which the original sample was selected, implying that startups are not present.

[8]This is the number of establishments that were present in the sample at least once over the entire twenty-quarter period.

count reported in two adjacent spells of the survey. The hiring and separation rates were computed using the information on the total number of hirings and separations reported by the respondent units in each spell of the survey. The dataset also contains information on the end-of-period head-count by type of contract. Combining this information with the establishment head-count permitted us to compute, for each establishment, the proportion of workers of the establishment with fixed-term contracts and employed on a part-time basis as well as the gender composition of the workforce.

To estimate the duration models in the second step of our empirical approach we would like to control for as many relevant characteristics of the establishments workforce as possible, in particular, if these may be interpreted as proxy variables for the magnitude of labor adjustment costs. Some of these variables are not present in the IEE dataset but they may be imported from the QP survey. This is implemented by merging each quarterly spell of the IEE data with the corresponding QP annual file. By doing so we are able to obtain information on the skill composition of the establishments' workforce (with nine levels, from Top Cadres to Apprentices), on the tenure distribution at the establishment level, and on the age of the firm the establishment is affiliated with. It is this dataset that results from the merge of the two sources that is used in Section 6.

3 The Distribution of Job and Worker Turnover

The obvious starting point to check for signs of lumpy adjustment processes is to examine the distribution of net and gross job flows.

The first notable fact is the extraordinary amount of inaction in the data - for 74.7 percent of the establishments in the dataset employment remains unaltered over the course of an entire quarter (Figure 1). In terms of gross flows, the proportion of units reporting zero hires or zero separations is 83.7 and 80.6 percent, respectively. *On average, at least three quarters of all observed units do not change employment, hire any worker or separate from any of its workers over an entire quarter.* These results document a previously unsuspected degree of inaction which is clear and direct evidence of the presence of non-linearities in the adjustment technology at the micro-level.

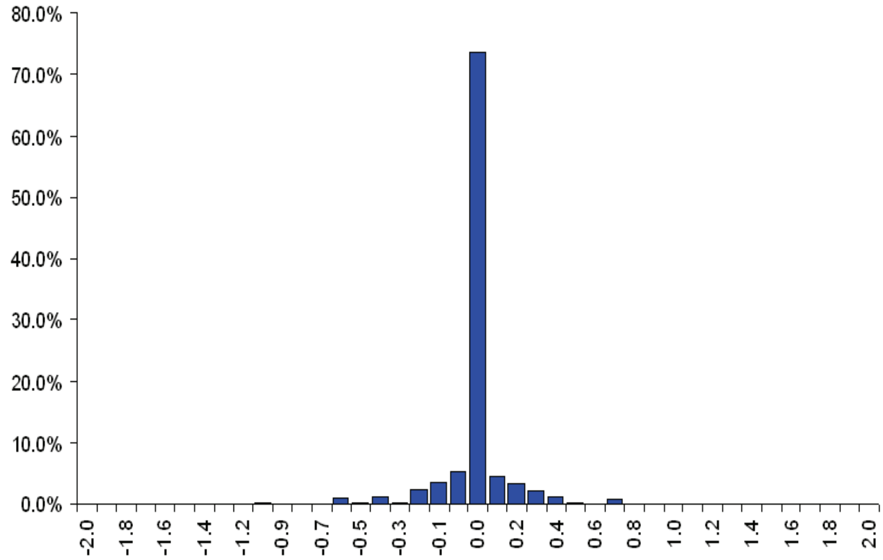

Figure 1: Distribution of Net Employment Changes (1991-95).

Zero net employment change is not synonymous to complete inaction. Establishments with stable employment hire every quarter one percent of their workforce (Table 1). These are replacement hires, implying that the same number of workers leave the establishment over the quarter, the majority (60 percent) voluntarily. The intensity of workers flows in this group of establishments combined with their large numbers originates that "inactive" units are responsible for 10.3 percent of all the hiring activity in the economy and 8.5 percent of all separations (Table 1).[9]

To check for the importance of large and small adjustment episodes, we also plotted the distribution of job creation and job destruction - Figure 2. That figure represents the proportion of jobs created (destroyed) by establishments expanding (contracting) at different growth rate intervals (as measured in the horizontal axis). By design, establishments with zero job turnover (which are a vast majority)

[9]Using French monthly Abowd *et al.* (1999) also find that stable establishments are not "inert". Compared to their results, our findings indicate that establishments are only slightly more stable in Portugal than in France. However, the comparison is not straightforward because data frequency differs between the two studies (monthly data in the French case, quarterly data here).

	All	$\Delta E < 0$	$\Delta E = 0$	$\Delta E > 0$
Hiring Rate	3.7	1.5	1.0	11.7
Separations Rate	4.5	10.1	1.0	2.6
Worker Turnover Rate	8.1	11.6	2.0	14.2
Job Creation Rate	2.3	0.0	0.0	9.1
Job Destruction Rate	3.1	8.5	0.0	0.0
Job Reallocation Rate	5.4	8.5	0.0	9.1
Churning Rate	2.8	3.1	2.0	5.1
Quit Rate	2.1	4.3	0.6	1.6
% of all establishments	100.0	14.1	74.7	11.2
% of all hires	100.0	14.5	10.3	75.2
% of all separations	100.0	78.0	8.5	13.5

Table 1: Job and Worker Turnover, by Employment Regime.
ΔE =Net employment change. Hiring (Separations) Rate equal the total number of hires (separations) divided by the period's employment average; temporary separations (maternity leave and other paid leaves, departure to military service, *e.g.* as well as subsequent re-entries were excluded. Worker Turnover Rate is the sum of the hiring and separation rates. Churning Rate equals the difference between the worker turnover rate and the job reallocation rate; it is the part of the worker turnover that is not due to the creation and destruction of positions. The Quit Rate is the number of quits (workers who left either voluntarily or because of a mutually agreed termination of contract) divided by the period's employment average.

are excluded from this figure as their contribution to total job creation or job destruction is null.[10] The bars to the right of the origin correspond to job creation and those to the left to job destruction. Smaller episodes of job creation and destruction (those that imply an employment variation of as much as 10 percent) are concentrated in the first columns to the right and to the left of the origin.

The height of these two columns indicates that establishments experiencing mild employment changes account for about 30 and 34 percent of all job creation and destruction, respectively. The complement to this information is that, on both margins, job flows are concentrated in establishments that are going through sharp employment changes: the share of job creation accounted for by establishments expanding more than 10 percent (conventionally measured) is 70 percent, whereas the corresponding figure for job destruction is 66 percent. Concentration is slightly greater for job creation than for job destruction, but both spread over the entire

[10] All job and worker flows were computed according to the standard Davis and Haltiwanger definitions (see Davis et al., 1996). Over the sample period, quarterly job turnover (start-ups and shutdowns excluded) is equal to 5.4 percent (2.3 for job creation and 3.1 for job destruction) and quarterly worker turnover is equal to 8.1 percent (3.7 percent for hirings and 4.5 percent for separations). For details, see Varejão (2003).

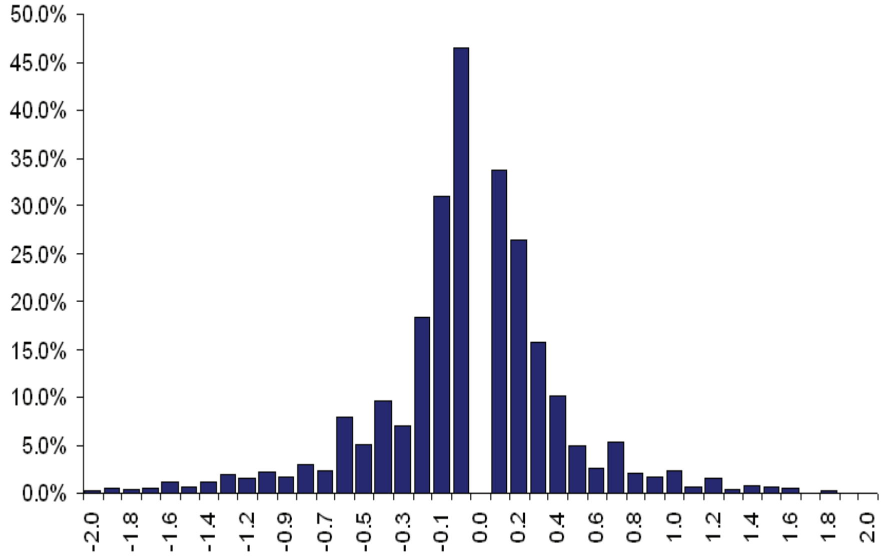

Figure 2: Distribution of Job Creation and Job Destruction (1991-95).

range of employment growth rates.

The distribution of gross job flows - hiring and separations - is represented in Figures 3 and 4. The height of each column in this figure measures the proportion of all hirings (separations) that are accounted for by establishments hiring (firing) workers at different rates (measured on the horizontal axis). The height of the two first columns in each panel indicates that only 34 percent of all hirings and 36 percent of all separations occur at establishments hiring or separating in a single period the equivalent to less than 10 percent of its average workforce in the same period. But the tails of both distributions also indicate that a non-trivial number of establishments experience extreme episodes of hiring and firing.

Inaction pervasiveness and fat tails in the distribution of job flows indicate how important lumpy adjustment is. For both net and for gross employment flows, strong evidence of lumpy adjustment coexists with signs of smooth adjustment.

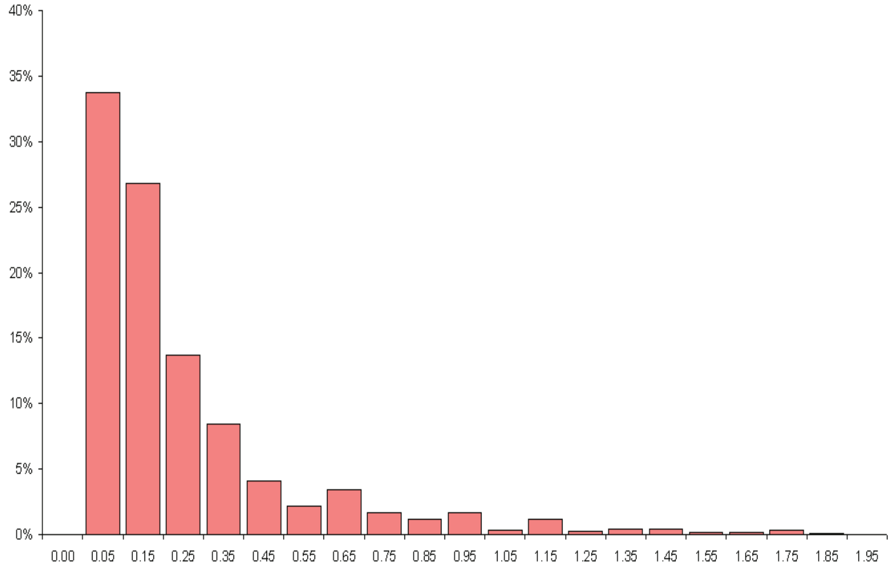

Figure 3: Distribution of Hirings

4 Spikes in Individual Employment Series

The distinctive characteristic of the pattern of employment adjustment implied by non-convex adjustment cost structures is the presence of spikes - *i.e.*, large relatively to the remaining adjustment episodes but also infrequent moments of sharp employment adjustment. Adjustment qualifies as sharp if its magnitude is of an order higher than that observed for most of the sample period.

An appropriate way of checking for the presence of spikes is to put each establishment's adjustment record in one quarter against the background of its entire record over the whole sample period (twenty quarters). Hence, we computed quarterly rates of turnover (net and gross) on a establishment-by-establishment basis. Three series for each unit in the panel - one for the net employment change, another for the hiring rate and the third for the separation rate - were thus obtained. Each individual series is then ordered from its highest value (rank 1) to the low-

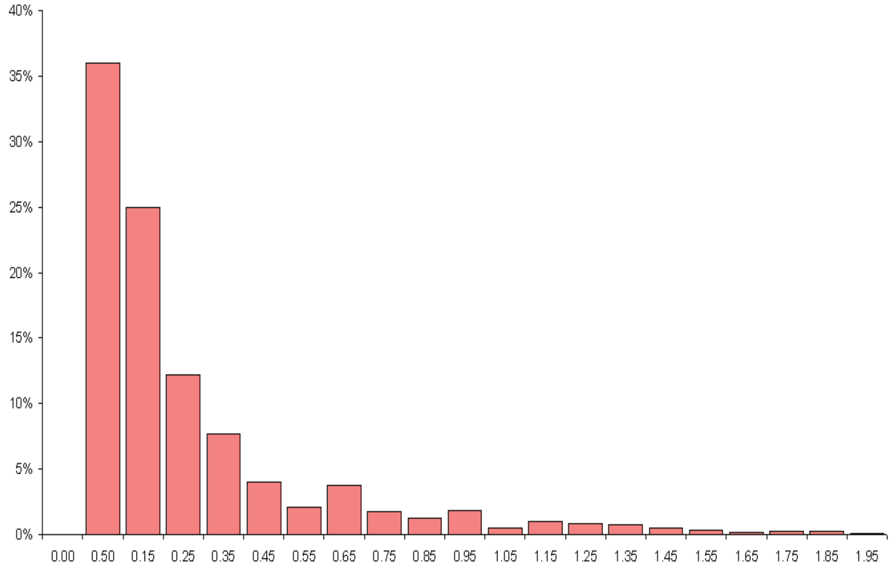

Figure 4: Distribution of Separations

est (rank 20).[11] If the employment series exhibits spikes, the first ranks of each individual series should be of a magnitude significantly greater than that of the remaining ranks. For example, if only one spike occurred during the whole sample period, then rank 1 corresponds to the sole period with a spike and will be much greater than rank 2 and all the subsequent ranks, which, in this case, will not correspond to spikes. If no spikes occurred (as we expect if adjustment costs are convex), then all the 20 ranks of each series will be of a similar magnitude.

In the final step, the average of each rank was computed across establishments. These figures are represented in Figures 5, 6, and 7. What they tell us is, for example, for hiring rates, that the sharpest hiring episode, which for different plants may have occurred in different calendar quarters, corresponds to an average hiring rate of 18 percent (rank 1). The figures corresponding to the remaining ranks should be interpreted similarly, remembering that rank 2 corresponds to the

[11] Here we follow the approach adopted by Doms and Dunne (1998) in their study of plant-level patterns of capital accumulation. Only the establishments present in the sample throughout the entire twenty quarter-period - a total of 2,181 - were included in these calculations.

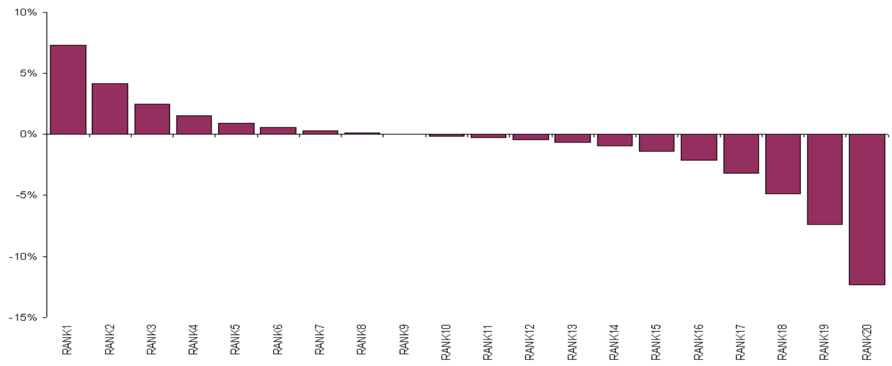

Figure 5: Net Employment Flow Rates, by Rank

second sharpest episode, and so on.

The purpose of constructing these series is to compare the magnitude of the highest rank of each series (the highest and the lowest in the case of the net employment change series) to the adjacent ranks. As discussed, the difference between the highest and the second highest ranks in each series measures the relative importance of the two sharpest adjustment episodes, large differences indicating the presence of spikes and lumpy adjustment processes.

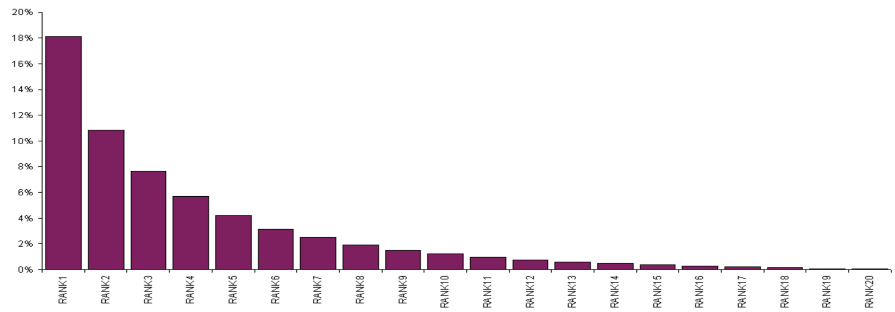

Figure 6: Hiring Rates, by Rank

For the net employment change series the mean of rank 1 is 7.3 percent and of rank 20 is -12.3 percent (Figure 5). This means that the greatest (least) net employment change corresponds to 7.3 (-12.3) percent of the average employment in the quarter in which the change occurred. Figure 5 also indicates that rank 1

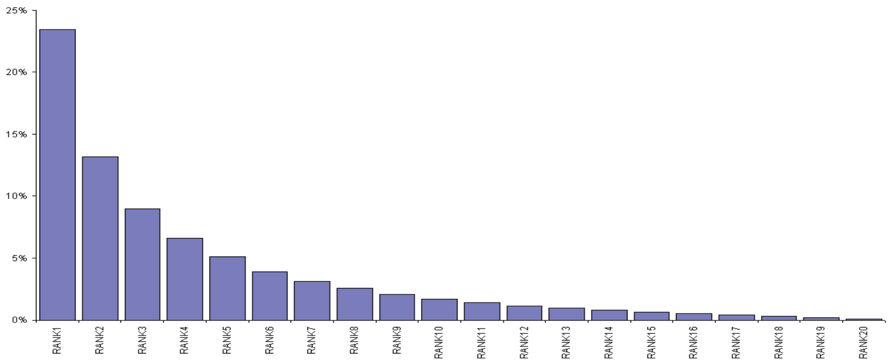

Figure 7: Separation Rates, by Rank

is more than 70 percent higher than rank 2 and rank 19 is 66 percent higher than rank 20. This indicates that large episodes of net employment adjustment are, indeed, extreme events in the history of employment adjustment of the individual establishments. There is no way these results may be unequivocally taken to indicate the presence of lumpy adjustment. We do, however, refer to the simulation exercise done by Doms and Dunne (1998) who, in the case of capital, find that frictionless adjustment is symmetric and does not drop as quickly or have as many periods with low capital accumulation activity as in real data. Moreover, with lumpy adjustment, the height of each rank falls sharply after the first rank and then stays close to zero as it also happens with their data. Our results display a pattern of adjustment closer to that obtained with real data on capital and with lumpy adjustment on simulated data than to simulated frictionless data.

Evidence in favor of lumpy adjustment is even clearer with gross flows. [12] At its maximum, the hiring rate represents about 18 percent of the establishment's workforce and this percentage drops off significantly after rank 1 (Figure 6). An even more pronounced picture is obtained on the separations' side. The average of the establishment-level maximum separation rate rounds off to 23 percent and it also drops off significantly after rank 1 (Figure 7).[13] Both hiring and separa-

[12] When comparing the mean values of the net employment change and of hires or separations in each rank, it should be remembered that some units may be expanding or downsizing throughout all of the 20 quarters surveyed, in which case they artificially reduce the mean value of each rank but only in the case of net employment flows.

[13] The pattern of net employment adjustment depicted in Figure 5 could also imply that adjustment is lumpier in cases of workforce reduction, although this would have to be controlled for by using data on the possible

tion rates are below 5 percent after rank 5 and remain above zero until rank 20, indicating how infrequent even mildly large adjustment episodes are.

5 Quarterly Transition Rates across Employment Regimes

The importance of large and infrequent episodes of employment adjustment was documented in previous sections. However, if this pattern of adjustment is to be attributed to non-convexities in the adjustment cost technology, it is essential to also analyze the sequence of events. Convex adjustment costs imply that one period of adjustment is followed by yet another period of adjustment, the intensity of episodes decreasing over time. On their side, non-convex adjustment costs imply that one period of adjustment is followed by periods of inaction.

To distinguish between these two adjustment patterns, all establishments in each period were classified into one employment regime and their situation one period ahead was recorded. Six alternative employment regimes as defined in Table 2, were considered. This information was then used to compute the probabilities of transition across regimes. With convex adjustment costs, we should observe high probabilities of false transitions (transitions into the same regime). With non-convex adjustment costs we should observe high probabilities of transition to the inaction regime, which should be a resilient regime.

The focus of our analysis is therefore on the main diagonal of the matrix of probabilities of transition across employment regimes. High values on this diagonal must be taken as signals of smooth adjustment, except for the cell corresponding to the inaction regime. Signals of lumpy adjustment must show as high values in the third column of the matrix, where the probabilities of transition from action to inaction and of inaction persistence are documented.

Looking first at the main diagonal of the matrix in Table 1, it becomes clear that with the exception of the expansion regimes (regimes 4 and 5), establishments in each regime are likely to be in that same state one period ahead. Expanding establishments (regimes 4 and 5) will most likely move into the inaction regime

asymmetry of shocks.

	Regime					
Regime	**1**	**2**	**3**	**4**	**5**	**6**
1 ($\Delta\ E < 0,\ H = 0$)	29.7	15.0	27.3	5.3	12.3	10.0
2 ($\Delta\ E < 0,\ H > 0$)	21.0	34.0	7.3	7.3	7.2	23.2
3 ($\Delta\ E = 0,\ H = 0$)	14.5	1.9	70.0	3.2	8.5	2.0
4 ($\Delta\ E = 0,\ H > 0$)	20.7	15.5	24.9	11.2	13.0	14.8
5 ($\Delta\ E > 0,\ S = 0$)	24.8	8.9	36.0	7.6	15.4	7.3
6 ($\Delta\ E > 0,\ S > 0$)	15.1	30.0	7.3	7.4	8.9	31.4

Table 2: Transition Across Employment Adjustment Regimes.

(regime 3). Seventy percent of all establishments that visit the inaction regime in one quarter will still be in that same regime in the subsequent quarter.

Column three tells us that those establishments that make a true transition move primarily to the inaction regime (the exceptions being transitions originating in regimes 2 - employment declining, but hiring-, and in regime 6 - employment increasing but with separations).

The resilience of the inaction regime and, particularly, the importance of this regime as a destination of all establishments that make a transition from one quarter to the next are consistent with fixed adjustment costs. This result should be emphasized as the regime definition that has been used biases the results in favor of smooth adjustment. Here, for an establishment to be classified as inactive, not a single worker is allowed to move in or out of the establishment. [14] Complete inaction is even less likely because natural attrition, which is observed as a visit to one action regime (regime 1 or 2), implies positive separations. [15]

[14] This also explains why the pattern of transitions described varies significantly across establishment size classes. For very small establishments (1 to 4 employees) the probability of false transitions originating in the inaction regime may be as high as 88 percent, but this probability is only 44 percent for establishments with more than 1000 employees.

[15] Arguments in favor of using a relative criterion, as opposed to the absolute zero criterion used here to define the inaction regime, can be found. Relative measures could be preferred if, as it is here, we cannot discriminate between employer and employee-initiated separations. However, in a strict formulation, fixed adjustment costs imply that the costs borne by the establishment by hiring/firing (expanding/contracting by) one worker are exactly the same of larger similar actions. This is, of course, why we expect lumpy rather than smooth adjustment when this structure of adjustment costs dominates.

6 A Duration Model of Employment Adjustment

6.1 Estimation Procedure

The estimation of the hazard function, as applied to the context of employment adjustment, starts with the definition of the duration variable (t) that measures the establishment's time of stay in the inaction regime. For that purpose, a flow-sampling scheme was adopted. According to this scheme, each establishment is selected upon entry to the inaction regime (at which point its individual clock is set to zero) and followed until exit time. All units are observed over a fixed time interval (from the first quarter of 1991 to the fourth quarter of 1995). Hence, left censoring is eliminated by construction, but right censoring may exist and must be accommodated.

A useful concept in statistical analysis of a duration phenomenon is the *hazard function*. In the study of inaction duration, the hazard function gives the instantaneous probability of adjusting employment at t, given that the establishment stayed inactive until t

$$h(t) = \lim_{\Delta t \to 0} \frac{(P(t \leq T < t + \Delta t \mid T \geq t)}{\Delta t} = \frac{f(t)}{1 - F(t)} = \frac{f(t)}{S(t)}. \tag{1}$$

where $f(t)$ is the probability density function, $F(t)$ is the distribution function, $S(t)$ is the survival function. A useful function is the integrated hazard function

$$\Lambda(t) = \int_0^t h(u)du \tag{2}$$

which relates to the survivor function simply by

$$S(t) = exp\left(-\int_0^t h(u)du\right) = exp(-\Lambda(t)) \tag{3}$$

In this paper we employ a conventional Weibull hazard model

$$h(t) = \rho\lambda^\rho t^{\rho-1} \tag{4}$$

which implies the following survival function:

$$S(t) = exp[-(\lambda t)^{\rho}] \tag{5}$$

and the corresponding cumulative hazard function

$$\Lambda(t) = (\lambda t)^{\rho} \tag{6}$$

The Weibull distribution function is a natural choice since it allows a direct test of duration dependence based solely on its shape parameter ρ. A ρ parameter lower than 1 indicates negative duration dependence. Symmetrically, $\rho > 1$ implies monotonic increasing hazard rates through time. An exponential duration distribution (and a constant hazard function) is implied by $\rho = 1$.

In this paper we shall also distinguish between two exit modes out of the inaction regime: employment increase or decrease. Thus, we define cause-specific hazard functions to destination j

$$h(t)_r = \lim_{\Delta t \to 0} \frac{(P(t \leq T < t + \Delta t, R = r \mid T \geq t)}{\Delta t} \tag{7}$$

which yield the aggregate hazard function

$$h(t) = \sum_{j=1}^{2} h_j(t) \tag{8}$$

and the survivor function

$$S(t) = \prod_{j=1}^{2} S_j(t) \tag{9}$$

where $S_j(t) = e^{-\Lambda_j(t)}$ and $\Lambda_j(t) = \int_0^t h_j(u)du$.

The model has a conventional competing risks interpretation. In this framework, a latent duration (T_j) attaches to each exit mode. We only observe the minimum of each latent variable. If risks are assumed to be independent, with continuous duration, this model simplifies to two separate single-cause hazard models.

A common way to accommodate the presence of observed individual heterogeneity is to specify a proportional hazards model

$$h(t \mid x) = h_{0j}(t)exp(x'\beta_j) \tag{10}$$

where $h_{0j}(t)$ denotes the baseline specific hazard function, that is, the hazard function corresponding to zero values for the covariates x. In this case, the covariates affect the hazard function proportionally (i.e. $\frac{dh(x)}{dx_k} = \beta_k h(x)$). An implication of this assumption is that the impact of the covariates does not change (in relative terms) with the progression of the spell of inaction.

Our information on the elapsed duration of inaction is grouped into quarterly intervals (while transitions can only be identified over a fixed interval of one quarter). Covariates are time-varying because they may change over the course of the inaction spell.[16] A convenient way to deal with time-varying regressors is to assume that covariates remain constant during each interval and to split the duration into distinct episodes.[17] To clarify this treatment lets assume that over the course of the spell $t = s + u$ covariates change at s. Covariates remain x_1 during the first interval and change to x_2 during the second interval. In this case, the survival function, conditional on the history of the covariates (X_t) can be written as

$$S_j(t \mid X_t) = [S_{0j}(s)]^{e^{x'_1\beta_j}} \frac{[S_{0j}(t)]^{e^{x'_2\beta_j}}}{[S_{0j}(s)]^{e^{x'_2\beta_j}}}. \tag{11}$$

A practical way to proceed is to split the data into quarterly episodes. Let $M = m$ denote the occurrence of an exit in a given quarter, where m is the realization of a discrete random inaction duration variable $M \in (1, ..., K)$. Proceeding this way one can rewrite the survivor function as

$$S_j(m \mid X_t) = \frac{\prod_{k=1}^{m}[S_{0j}(k)]^{e^{x'_k\beta_j}}}{\prod_{k=2}^{m}[S_{0j}(k-1)]^{e^{x'_k\beta_j}}}. \tag{12}$$

[16]Actually, some covariates are only allowed to change annually (e.g., workforce qualifications, tenure, and age of the firm) whereas others may change every quarter (employment, fixed-term contracts, gender, and part-time status.

[17]This is known as episode splitting. Stata is capable of dealing with (artificial) episode splitting.

With our sampling plan, where we collect the information of inaction duration for the flow of entrants into the inaction regime, the contribution of observation i for the likelihood function is simply

$$L(\theta|t,r,X_t) = \prod_{m=1}^{K-1}\prod_{j=1}^{2}[S_j(m-1|X_t) - S_j(m)]^{\delta_{mj}}[\prod_{m=2}^{K} S(m|X_t)]^{1-\delta_m} \tag{13}$$

where θ is a vector of parameters that include regression coefficients and baseline hazard parameters, and δ_{mj} is an indicator that assumes the value 1 if the firm exits to destination j during the m^{th} interval, and 0 otherwise. The indicator $\delta_m = \sum_{j=1}^{2}\delta_{mj}$ identifies complete durations, so that $1-\delta_m$ equals 1 for a censored observation. The contribution to the likelihood function from a censored observation is simply the product of the two specific survival terms ($\prod_{j=1}^{2} S_j(m)$), that is, the probability of not exiting to either employment growth or employment decline.

Empirical implementation of the model implies a definition of the no-adjustment regime. There is no such obvious definition. For that reason four alternative criteria were used.[18] These criteria are defined as follows:

- Absolute zero threshold on gross employment adjustment: the establishment is classified as inactive if, during the period, there were neither accessions nor separations to the establishment;

- Absolute zero threshold on net employment adjustment: the establishment is classified as inactive if, during the period, there was no change in the level of employment;

- Relative 10 percent threshold on net employment adjustment: the establishment is classified as inactive if, during the period, the change in the level of employment is less than 10 percent of the employment count at the beginning of the period;

[18] An additional definition setting a 2.5 percent threshold was also used but the corresponding results are not reported as they do not differ substantially from those corresponding to the second criterion listed here.

- Collective dismissal criterion: the establishment is classified as inactive whenever its employment level varies by less than two or less than five depending on whether the establishment employs fewer or more than fifty workers.[19]

The first criterion corresponds to the strictest definition of inaction as applied to gross employment adjustment. This would be the most appropriate for investigating the importance of, say, fixed adjustment costs, as these imply that the same cost is borne independently of the number of individuals joining or leaving the establishment and of the size of the establishment itself. The second definition also takes an absolute criterion but applies on net employment change, ignoring the magnitude of gross flows that may be going on at the same level of employment. However, because data on separations do not permit us to distinguish between firings and other separations (temporary separations, voluntary quits, retirements, or deaths) a relative threshold (here set at 10 percent of the beginning-of-period count) - the third criterion - may also be adequate.

Finally, the fourth criterion listed follows the legal rule applying to the definition of collective dismissals, which are submitted to a number of obligations and imply considerably higher firing costs than those applying to individual dismissals.[20]

Being able to use alternative definitions for the no-adjustment regime has the obvious advantage of permitting us to contrast the corresponding predictions and evaluate the sensitivity of the results to necessarily arbitrary thresholds.

Finally, there could remain an important sampling issue. We have been modeling, implicitly, the duration of an inaction spell. Repeated inaction episodes by the same establishment are frequently observed in the sample. This is adequate as long as we target the duration of representative spell of inaction. If, however, we are interested in the characterization of the adjustment of a representative estab-

[19]The legal definition applies to separations only. In the absence of an obvious corresponding criterion to apply on the hiring margin, the option was to set the same absolute thresholds on this margin as well, and work with an inaction region symmetric about zero.

[20]The Dismissals Act (Law 64-A/89) makes the distinction between individual and collective dismissals on the grounds of the number of individuals being dismissed within a three month period. For a dismissal to be termed collective and subject to the corresponding legislation, the law requires a minimum of two or five workers to be dismissed simultaneously (i.e., within a three month period), depending on the firm having fewer or more than 50 workers.

lishment our sampling plan would be seriously flawed. The problem arrives from oversampling short spells in the current sampling plan. That is, establishments that adjust quickly would contribute with a large number of spells, whereas establishments that adjust sluggishly contribute with much smaller number of spells. Apart from the obvious impact on frequency of short durations, it is not clear how the sampling scheme may affect the inferences if one wants to consider the establishment as the unit of observation. Fortunately, the issue can easily be settled. Indeed, if for each establishment we simply consider the first spell of inaction, one can recover a representative sample at the establishment level. We also obtained the estimates for this subsample of data. Results are presented in the appendix but they do not differ qualitatively from those obtained with the sample representative of the inaction spell.

6.2 Estimation Results

Results of fitting the duration model with no covariates added for the four alternative definitions of the no-adjustment regime are depicted in Table 3.[21]

The first result to notice is that, independently of how inaction is defined, the estimated values of the λ parameters of the Weibull distribution are low, indicating a low conditional probability of abandoning the no-adjustment regime. This is consistent with the evidence discussed previously that documented a substantial degree of inactivity and few quarterly transitions from inaction to action. The more demanding is the definition of inaction the lower is the baseline hazard. This finding is consistent with the fact that, conditional on entering more demanding inaction regimes, establishments are less likely to make a transition out.

Although low hazard rates are observed for the two exit modes - employment decline and expansion - they are higher in the decline destination case. However, this result should not be taken as evidence in favour of asymmetric adjustment

[21] Per quarter, the number of observations in each sample corresponds to the number of establishments that according to each inaction definition were inactive that period. Hence, the number of observations varies from panel-to-panel in Table 3 being highest for the two more demanding inaction criteria because establishments entering the inaction regime stay longer in that regime. For that reason each of them shows up in the sample more times.

	Employment Decline		Employment Expansion	
Gross Inaction (Absolute Zero Threshold)				
	coefficient estimate	std error	coefficient estimate	std error
λ	0.132	0.002	0.074	0.002
ρ	1.309	0.008	1.334	0.009
n		24075		24075
Log likelihood		-11257.9		-8192.6
Net Inaction (Absolute Zero Threshold)				
	coefficient estimate	std error	coefficient estimate	std error
λ	0.153	0.003	0.091	0.003
ρ	1.307	0.012	1.331	0.015
n		27510		27510
Log likelihood		-13760.5		-10514.8
Inaction (10 percent Threshold)				
λ	0.063	0.002	0.047	0.002
ρ	1.174	0.018	1.155	0.012
n		30752		30752
Log likelihood		-8764.1		-7005.9
Inaction (Collective Dismissal Criterion)				
λ	0.102	0.003	0.058	0.002
ρ	1.177	0.014	1.220	0.017
n		32808		32809
Log likelihood		-12470.9		-9096.8

Table 3: Weibull Distribution Duration Model.

costs because it is likely to be biased towards the employment decline margin as, for the most part, our sample corresponds to a downturn period in the Portuguese economy.

In all cases, the Weibull hazard function exhibits a positive duration dependence. The estimated ρ parameters are always greater than one and the notion of constant (or decreasing) hazard rates ($\rho = 1$) is soundly rejected. This result has an interest of its own because we know that upward-sloping hazards in the context of "time since last adjustment" are characteristic of nonconvex adjustment costs. A link between the slope of the hazard function and the structure of adjustment costs can be established under some assumptions. Cooper *et al.* (1999)

show that a simple convex cost of adjustment model with positively serially correlated shocks and enough dispersion are inconsistent with upward-sloping hazard functions. The authors further generalize this result to other convex adjustment cost models. Nilsen and Schiantarelli (2003) also take upward-sloping hazards to be "consistent with presence of fixed adjustment costs that eventually dominate" (p.1035). [22]

However, in this very stylized model the estimated shape parameters (of the Weibull distribution) are barely above one. It is, in fact, well known from the duration analysis literature that failure to properly account for individual heterogeneity biases the results towards negative duration dependence.

Control for individual specific effects was, thus, implemented via the use of regression analysis. A set of covariates contemporaneous to the timing of events was added to the model. These covariates control for the size of the establishment (as measured by the log of total employment), the proportion of workers in the establishment with fixed-term contracts or part-time contracts, the gender and skill-structures of the workforce, and the proportion of workers with low tenure (less than three years) at the establishment. The age of the firm the establishment belongs to and the last employment regime (expansion or decline) the establishment visited before entering the current spell of inaction are also controlled for. Time and industry dummies are also included in the regression. Results are reported in Table 4.

The estimated ρ parameters show that controlling for observed individual heterogeneity increases visibly the slope of the hazard function, for all inaction regime definitions. Remarkably, the estimated ρ parameters suggest that the shape of the hazard functions is now very similar across destination states. The fact that controlling for the magnitude of adjustment costs via a number of proxies included in the control set removes the asymmetry between employment expansion and decline

[22] It is well known that the time until a Brownian motion stochastic process hits a fixed barrier follows an inverse-Gaussian distribution, which is characterized by an inversed U-shaped hazard function. We also ran a number of (admittedly ad-hoc) Monte-Carlo simulations using a stationary weakly dependent autoregressive process with normally distributed errors and two barriers. In all cases we end up with the indication of an increasing hazard function.

is an indication that idyosincratic shocks are the major force behind the signs of asymetric adjustment in Table 3.

Results in Table 4 also show that for all the criteria but the third, larger firms are those facing the highest probability of exiting inaction (a one percent increase in total employment increases the hazard rate by 0.48 to 0.66 percent).

However, it is interesting to look more carefully at the estimated coefficient of the log of employment in the third specification. Remember that this estimate corresponds to the more demanding definition of action for variations of employment as large as 10 percent of the beginning-of-period count, establishments are still considered inactive according to this criterion. Put differently, it takes a net employment variation as large as 10 percent of the beginning-of-period count for an establishment to be considered as exiting the no-adjustment regime. What the estimate of the employment coefficient tells us is that larger establishments are the least likely to exit the no-adjustment regime so defined, although they are more likely to do so for alternative inaction definitions. This necessarily implies that most of the action we observed among larger establishments corresponds to relatively small adjustment episodes.

The proportion of the workforce with fixed-term contracts was included as a regressor because costs of adjusting labor are lower if establishments employ temporary workers. It is also costumary to consider part-time work as a contingent or flexible form of work and for that reason we also control for the proportion of part-time workers.

	Employment Decline		Employment Expansion	
Gross Inaction (Absolute Zero Threshold) $N = 24075$				
	coefficient estimate	std error	coefficient estimate	std error
Employment (log)	0.648	0.016	0.578	0.020
Fixed-term contracts (% of total)	0.739	0.086	0.595	0.102
Part-time workers (% of total)	-0.132	0.154	-0.341	0.187
Gender (% of total)	0.074	0.056	0.101	0.068
Skilled (% of total)	-0.743	0.146	-0.962	0.187
Low tenure (% of total)	1.524	0.116	2.474	0.113
Age of the firm	0.001	0.001	-0.010	0.002
From employment declining regime	0.029	0.032	0.170	0.040
λ	0.096	0.005	0.052	0.003
ρ	1.894	0.021	1.913	0.025
Log likelihood		-6967.0		-5554.2
Net Inaction (Absolute Zero Threshold) $N = 27510$				
Employment (log)	0.655	0.014	0.641	0.017
Fixed-term contracts (% of total)	0.633	0.079	0.554	0.090
Part-time workers (% of total)	-0.133	0.142	-0.306	0.166
Gender (% of total)	0.093	0.051	0.093	0.060
Skilled (% of total)	-0.704	0.133	-0.731	0.163
Low tenure (% of total)	1.503	0.105	2.469	0.102
Age of the firm	0.001	0.001	-0.009	0.002
From employment declining regime	0.056	0.029	0.180	0.035
λ	0.084	0.004	0.051	0.003
ρ	1.957	0.020	1.995	0.023
Log likelihood		-8182.4		-6746.8
Inaction (10 percent Threshold) $N = 30752$				
Employment (log)	-0.126	0.016	-0.122	0.019
Fixed-term contracts (% of total)	1.187	0.091	0.719	0.106
Part-time workers (% of total)	0.370	0.163	0.040	0.181
Gender (% of total)	0.172	0.072	0.080	0.081
Skilled (% of total)	-0.668	0.172	-1.169	0.222
Low tenure (% of total)	1.137	0.121	2.039	0.115
Age of the firm	0.0001	0.002	-0.016	0.002
From employment declining regime	-0.030	0.041	0.354	0.048
λ	0.029	0.002	0.020	0.001
ρ	1.444	0.022	1.484	0.026
Log likelihood		-6727.4		-5301.3
Inaction (Collective Dismissal Criterion) $N = 32809$				
Employment (log)	0.531	0.015	0.481	0.019
Fixed-term contracts (% of total)	1.141	0.091	0.796	0.103
Part-time workers (% of total)	0.711	0.194	0.062	0.227
Gender (% of total)	0.108	0.061	-0.024	0.072
Skilled (% of total)	-0.399	0.167	-0.658	0.216
Low tenure (% of total)	1.262	0.133	2.639	0.126
Age of the firm	0.001	0.001	-0.008	0.002
From employment declining regime	0.124	0.033	0.014	0.040
λ	0.033	0.002	0.025	0.002
ρ	1.576	0.018	1.648	0.023
Log likelihood		-8552.6		-6539.2

Table 4: Regression Model Estimates (Weibull distribution; unit of observation: spell of inaction) .

Results indicate that the proportion of fixed-term contracts has, indeed, a strong positive effect on the establishments conditional probability of exiting inaction. Raising the proportion of temporary workers by one percentage point increases the conditional probability of exiting the inaction regime between 0.6 and 1.2 percent, depending on the regime definition and exit mode. The fact that the largest estimates for the coefficient of the fixed-term contract variable were obtained when the most demanding definitions of inaction (the 10 percent employment threshold and the collective dismissal criterion) are used indicates that fixed-term contracts are particularly instrumental in facilitating severe employment adjustment. In turn, this indicates that, to some extent at least, they play the role of buffer-stocks. The estimated coefficient of fixed-term contracts is larger when establishments exit the inaction regime to enter the employment decline destination as compared to the alternative exit mode (employment expansion). Because all employers have the option to hire new workers on fixed-term contracts, the probability of exiting the inaction regime is less determined by the presence of a pool of temporary workers if they are moving to the expanding regime as compared to the declining regime. However, our results show that the effect is also positive when the destination regime is expansion. We take this as an indication that the hiring technology differs with the type of contract and learning is important. This would explain why firms that employ larger shares of temporary workers are more likely to move to the expanding regime.[23]

A positive sign for the coefficient of the fixed-term contract variable is direct evidence of the importance of adjustment costs. In fact, the presence of a pool of temporary workers makes it less costly for employers to fire some workers as they have the option to choose to fire those on temporary contracts. Our results indicate that this is actually what employers do. Irrespective of the employment regime the establishment is in, employers choose to initiate an adjustment spell with their temporary workforce - the rate of turnover of temporary workers is quite

[23]The share of workers with fixed-term contracts varies significantly from industry-to-industry - it is as low as 1.7 percent in the Public Utilities sector but it reaches 17.6 percent in Retail and Wholesale Trade and 40.8 percent in Construction.

high and much higher than it is in the case of workers with permanent contracts (Table 5).

		Hiring rate	Separation rate	Worker Turnover
Expanding establishments	Permanent workers	6.1	1.4	7.5
	Temporary workers	34.2	7.6	41.8
Stable establishments	Permanent workers	0.5	0.7	1.2
	Temporary workers	5.5	4.3	9.8
Declining establishments	Permanent workers	0.6	7.3	7.9
	Temporary workers	7.4	27.8	35.2

Table 5: Quarterly Worker Turnover, by Type of Contract .

The rate of turnover of temporary workers is much higher than it is for permanent workers, specially on the hiring margin and for expanding establishments - this is consistent with the fact that in the Portuguese labor market 62 percent of all new contracts are temporary. On the separations side, the proportion of fixed-term contracts is smaller - 43 percent - but this is because we cannot isolate exits to retirement which disproportinally hit permanent workers. Still, for declining establishments the separation rate of temporary workers reaches 27.8 percent quarterly. Even for stable establishments the rate of turnover of temporary workers is five times greater than for permanent workers - 9.8 percent *versus* 1.2 percent. The fact that the hiring rate of temporary workers exceeds their separation rate in stable establishments is direct evidence of temporary contracts being used to screen workers for permanent positions even if they are also used as buffer-stocks.

For the part-time variable, results indicate that part-time work has no statistically significant effect on the probability of adjusting employment. One could expect that establishments employing workers on a part-time basis would find it less costly to hire or fire as part-time contracts are usually easy to terminate. Yet, this is not necessarily true in Portugal where part-time contracts may be temporary or permanent and inherit all the features of their full-time equivalent. This may be the reason why the variable shows as not-significant.

Two addtitional variables - Skilled and Low tenure - also have an adjustment cost interpretation as they control for the proportion of skilled workers and workers with tenure at below three years and adjustment costs are known to increase with the former and decrease with the latter. The results are consistent with this interpretation. The larger the proportion of skilled workers at the establishment the smaller is the probability that it moves to any other destination independently of how inaction is defined. This could result of more demanding hiring procedures for skilled workers but also of complementarities between general human capital and training in which case firing costs include a larger component of foregone profits. Equivalently, the larger the share of low-tenured workers at the establishment the more likely it is to exit inaction as these are less costly to fire both because they have received less job-specific training and because they are more likely to be on a trial period at the end of which bad matches are expected to be terminated.

In an attempt to control for the conditions that initiated the current spell of inaction, a dummy variable that indicates whether employment decline or employment expansion preceeded the current inaction episode was also included. No clear pattern emerges from this exercise, suggesting that state dependence (generated by persistent product demand shocks, for example) does not appear to play an important role. Having said that, it is still true that units that entered the current inactivity spell from a declining episode are more likely to exit inaction independently of the exit mode.

7 Conclusions

If adequate matched employer-employee longitudinal data are available, it is possible to assess the relative importance of convex and non-convex adjustment cost structures. Signs of both patterns of adjustment were investigated by checking the importance of extreme events (jumps in employment processes), their frequency and sequel. Unequivocal signs of discrete adjustment consistent with fixed adjustment costs were found at all these different levels. Large employment changes (larger than 10 percent of the establishments workforce) account for two-thirds of total job creation and destruction, and also of all gross employment flows. Inaction is pervasive with 75 percent of all units surveyed not changing the level of employment over one quarter, and 72 percent also not hiring or firing a single individual over the same period. Visits to any regime implying some sort of adjustment are frequently followed by a transition to the inaction regime, which emerges as highly resilient.

The estimated hazard function for the probability of employment adjustment conditional on the duration of the inaction spell is upward sloping which is consistent with the presence of non-convexities in the technology of adjustment. Moreover, our results confirm that adjustment costs do influence the frequency of adjustment. The establishment-level proportion of temporary workers and low-tenure workers have a positive and significant impact on the conditional probability of adjustment. Conversely, the impact of the proportion of skilled workers is negative. These results survive changes in the definition of the inaction regime and are valid for the two exit modes (employment expansion and decline). Some signs of asymmetric adjustment were found - the baseline hazard is higher in the employment decline destination - although we cannot tell whether this is due to asymmetric adjustment costs or asymmetric shocks.

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A Appendix

	Employment Decline		Employment Expansion	
Gross Inaction (Absolute Zero Threshold) $N = 8775$				
	coefficient estimate	std error	coefficient estimate	std error
Employment (log)	0.715	0.025	0.615	0.031
Fixed-term contracts (% of total)	0.537	0.144	0.677	0.169
Part-time workers (% of total)	-0.585	0.263	-0.230	0.287
Gender (% of total)	0.084	0.092	0.085	0.113
Skilled (% of total)	-0.576	0.268	-0.891	0.349
Low tenure (% of total)	1.731	0.171	2.159	0.182
Age of the firm	-0.002	0.002	-0.009	0.003
From employment declining regime	0.217	0.054	0.281	0.068
λ	0.070	0.006	0.040	0.004
ρ	2.003	0.035	2.042	0.042
Log likelihood		-2421.0		-1970.6
Net Inaction (Absolute Zero Threshold) $N = 9491$				
Employment (log)	0.694	0.022	0.671	0.025
Fixed-term contracts (% of total)	0.609	0.137	0.833	0.132
Part-time workers (% of total)	-0.316	0.240	0.013	0.247
Gender (% of total)	0.073	0.087	0.070	0.094
Skilled (% of total)	-0.398	0.248	-0.571	0.293
Low tenure (% of total)	1.634	0.165	2.079	0.167
Age of the firm	-0.001	0.002	-0.010	0.002
From employment declining regime	0.263	0.043	0.331	0.055
λ	0.063	0.005	0.036	0.003
ρ	2.069	0.034	2.148	0.031
Log likelihood		-2652.8		-2225.2
Inaction (10 percent Threshold) $N = 12171$				
Employment (log)	-0. 077	0.026	-0.158	0.032
Fixed-term contracts (% of total)	1.036	0.163	0.948	0.185
Part-time workers (% of total)	0.226	0.272	0.571	0.263
Gender (% of total)	0.158	0.126	0.166	0.140
Skilled (% of total)	-0.727	0.362	-1.549	0.486
Low tenure (% of total)	1.518	0.190	1.658	0.194
Age of the firm	-0.002	0.003	-0.024	0.004
From employment declining regime	0.393	0.085	0.612	0.095
λ	0.021	0.003	0.013	0.002
ρ	1.448	0.037	1.495	0.045
Log likelihood		-2310.2		-1750.2
Inaction (Collective Dismissal Criterion) $N = 14806$				
Employment (log)	0.626	0.025	0.568	0.030
Fixed-term contracts (% of total)	1.024	0.142	1.032	0.162
Part-time workers (% of total)	0.215	0.322	-0.075	0.365
Gender (% of total)	0.004	0.099	-0.004	0.122
Skilled (% of total)	-0.585	0.316	-1.095	0.441
Low tenure (% of total)	1.360	0.197	2.072	0.197
Age of the firm	0.00001	0.002	-0.015	0.003
From employment declining regime	0.213	0.054	0.052	0.071
λ	0.028	0.003	0.017	0.002
ρ	1.523	0.028	1.601	0.036
Log likelihood		-3300.5		-2469.5

Table 6: Regression Model Estimates (Weibull Distribution; unit of observation: establishment) .